1 A short history of bicycling

Introduction

Those who are ignorant of history are not, in truth, condemned to repeat it, as George Santayana claimed. However, people do spend a great deal of time reinventing types of bicycles and of components, and one purpose of this necessarily brief history is to give would-be inventors a glimpse of some of their predecessors. Sir Isaac Newton said that we make advances by standing on the shoulders of giants, but we must first know that there were giants and what they accomplished. Another purpose is to kill the many-headed Hydra of bicycling myths. People invent these myths—for instance, that Leonardo da Vinci or one of his pupils invented the chain-driven bicycle—for nefarious or self-serving or humorous purposes, and the myths are immediately picked up by journalists and enthusiasts and almost instantly become lore, however false. Historians repeatedly denounce the fakes, but the amateur historians continue to report them as if they were true. These people seem to practice a crude form of democracy: if they read something in ten publications and the contrary in one, then the one reported most often is, they believe, correct.

We have become the disciples of a group of cycle-historians that has become a powerful international movement having scholarly proceedings and meetings. Derek Roberts, the founder of the group, has written correction sheets for every new book incorporating cycling history, pointing out inaccuracies in detail. John Pinkerton encouraged Roberts to gather these together and published *Cycling history—myths and queries* (1991) in a further attempt to stem the tide of inaccurate versions of history. We are embarrassed to confess that Roberts had to write a correction sheet for the second edition of this book. In this present brief history we will endeavor to lay to rest previous myths, and we will do our utmost not to create more. We have been graciously guided by Roberts, by the late John Pinkerton, prominent member of the group and a publisher of cycling-history books, and by Hans-Erhard Lessing, a leading cycle-historian, former curator, and university professor. He himself has documented several major bicycling myths (some quoted below) previously regarded as historical facts. Others in this group who have been of particular help to the author are Nick Clayton and David Herlihy. Cycle historians themselves are far from agreement on many aspects of their profession: cycle history is a field in which views are strongly held and defended, and amateurs must tread with great care; the author has greatly appreciated this group's advice, which has not always been unanimous.

There have been three significant periods in cycling history, each covered in more detail below. Despite the myths of supposed earlier two-wheelers, the first bicycle (a "running machine" that the rider straddled and propelled with his feet on the ground) was invented in Germany in 1817, and this is when the history of the bicycle and the motorcycle begins. It led to a promising acceptance in several countries but was suppressed by the authorities in several places, so that by 1821 it had virtually died out. (Others, including Pinkerton [see below] believed that it was simply a fad of the rich and that fashions come and go in such a period.) It was not until the early 1860s that someone in France added cranks and pedals to the front wheel of a running machine, and another international rush developed. If we define a modern bicycle as a vehicle having two wheels in line connected by a frame on which a rider can sit, pedal, and steer so as to maintain balance, then this is the start of its history. This rush lasted much longer than that of 1817–1821. The front wheel was made progressively larger, and the high bicycle or "ordinary" was born. It was fun but it was dangerous,[1] and designers and inventors tried for many years to arrive at a safer machine. Success came with the so-called safety, first in 1878 with the Xtraordinary and the Facile, and reaching significant commercial success with John Kemp Starley's safeties of 1885 which, with Dunlop's pneumatic tires reinvented in 1888, became by 1890 very similar to the safety bicycle of today.

These, then, are the three principal developments that we shall discuss below in this short history. We shall also mention the tricycle period, the repeated enthusiasm for recumbent bicycles, and the enormous popularity of the modern all-terrain (or mountain) bicycle (the ATB).

Early history

It was through the use of tools that human beings raised themselves above the animals. In the broadest sense of the term, a tool might be something as simple as a stone used as a hammer or as complex as a computer controlling a spacecraft. We are concerned with the historical and mechanical range of tools that led to the bicycle, which—almost alone among major human-powered machines—came to use human muscles in a near-optimum way. A short review of the misuse of human muscle power throughout history (Wilson 1977) shows the bicycle to be a brilliant culmination of the efforts of many people to end such drudgery.

Many boats, even large ones, were muscle-powered until the seventeenth century. Roman galleys had hundreds of "sweeps" in up to three banks. Figure 1.1 shows a large seventeenth-century galley having fifty-four sweeps, with five men on each. The men were likely to be criminals, chained to their benches. A central gangway was patrolled by overseers

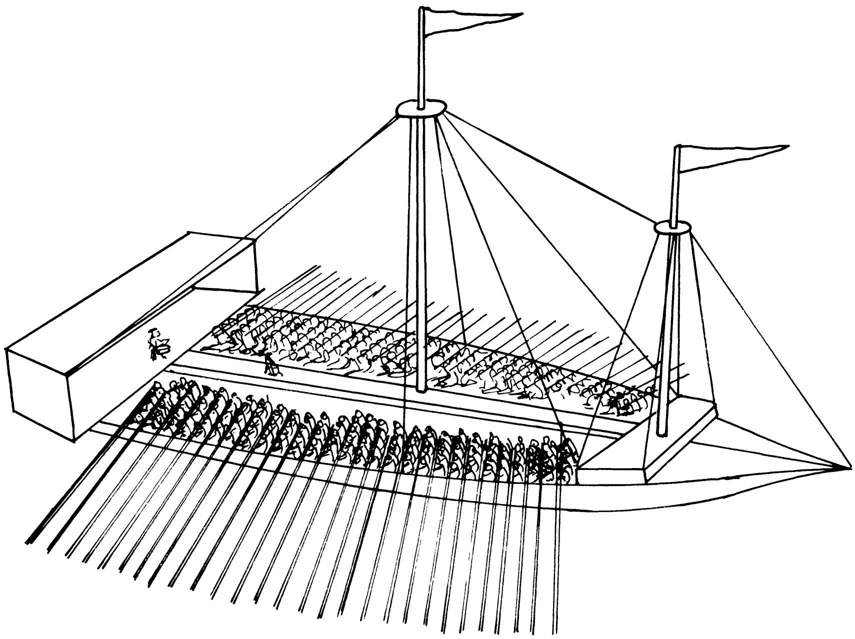

Figure 1.1
Early-seventeenth-century galley, with drummer in the stern and a whip-bearing overseer on the central gangway. (From a drawing in the British Museum reproduced in the *Encyclopedia Britannica*, sketched by Dave Wilson.)

equipped with whips to provide persuasion for anyone considered to be taking life too easily. The muscle actions used by these unfortunate oarsmen were typical of those considered appropriate in the ancient world. The hand, arm, and back muscles were used the most, while the largest muscles in the body—those in the legs—were used merely to provide props or reaction forces. (They didn't have the sliding seat of today's competitive rowers.) The motion was generally one of straining mightily against a slowly yielding resistance. With five men on the inboard end of a sweep, the one at the extreme end would have a more rapid motion than the one nearest to the pivot, but even the end man would probably be working at well below his optimum speed. Most farm work and forestry fell into the same general category. Hoeing, digging, sawing, chopping, pitchforking, and shoveling all used predominantly the arm and back muscles, with little useful output from the leg muscles. In many cases, the muscles had to strain against stiff resistances; it is now known that muscles develop maximum power when they are contracting quickly against a small resistance,

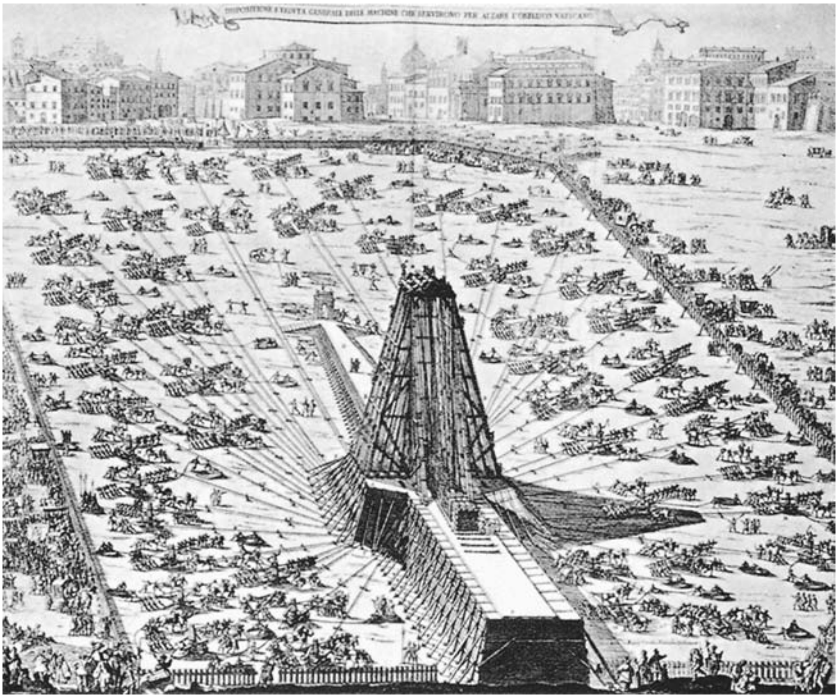

Figure 1.2
Engraving showing use of capstans in the erection of an obelisk at the Vatican in 1586. (The penalty for disrupting work was death.) (From N. Zabaglia, *Castelli e Ponti* [Rome, 1743].)

in what is termed a good "impedance match." We would call this good impedance match an optimum gear ratio.

One medieval example of the use of appropriate muscles in a good impedance match is the capstan (figure 1.2). Several people walked in a circle, pushing on radial arms, to winch in a rope. The capstan's diameter was chosen to give comfortable working conditions, and each pusher could choose a preferred radial position on the bar.

Other relatively satisfactory uses of muscle power were the inclined treadmill (figure 1.3) and Leonardo da Vinci's drum or cage for armaments (rotated by people climbing on the outside) (Reti 1974, 178–179), and treadmill-driven pumps (figure 1.4). This type of work may not have been pleasant, but per unit of output it was far more congenial than that of a galley slave.

The path of development, in this as in most other areas, was not a steady upward climb. Even though relatively efficient mechanisms using

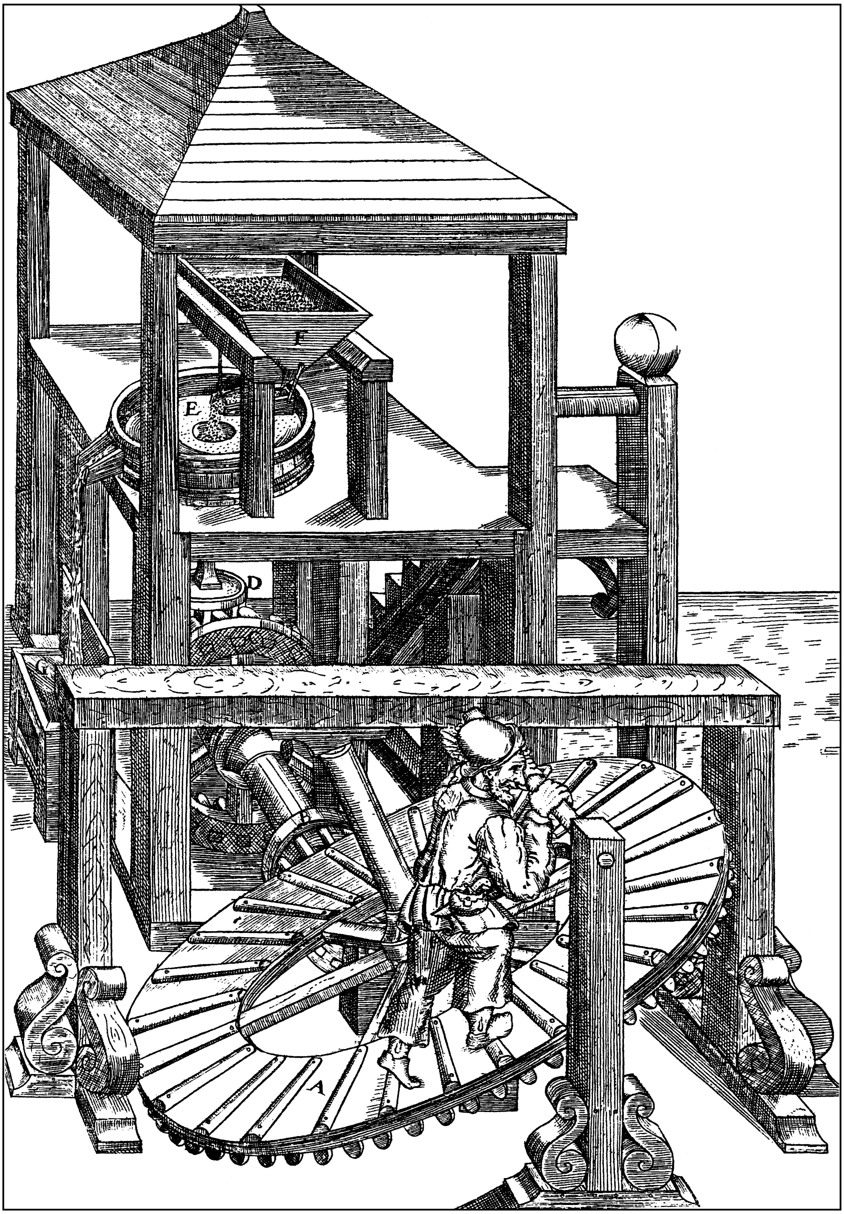

Figure 1.3
Inclined treadmill powering a mill. (From Gnudi and Ferguson 1987.)

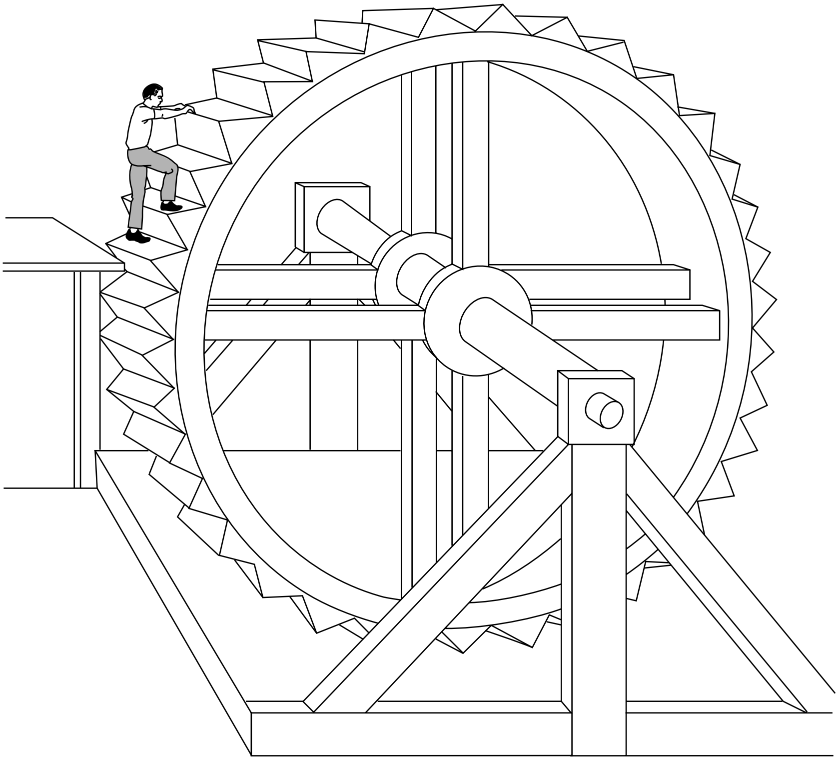

Figure 1.4
Leonardo's human-powered drum. (From Reti 1974.)

leg muscles at good impedance matches (figure 1.5) had been developed, sometimes hundreds of years earlier, some designers and manufacturers persisted in requiring heavy hand cranking for everything from drill presses to pneumatic diving apparatus to church-organ blowers, even though in all these cases pedaling seems clearly advantageous.

The first clearly human-powered vehicles known to history (if we exclude classes like wheelbarrows and carts pulled or pushed by men) were carriages supposedly propelled by footmen, in France in the 1690s (Ritchie 1975, 16). (An alleged earlier effort by a pupil of Leonardo da Vinci has been convincingly shown by Lessing [1998a] to be a fake.)

The first bicycle

It seems likely that the most important discovery in the development of the bicycle was made by chance. Baron Karl von Drais, a resident of Mann-

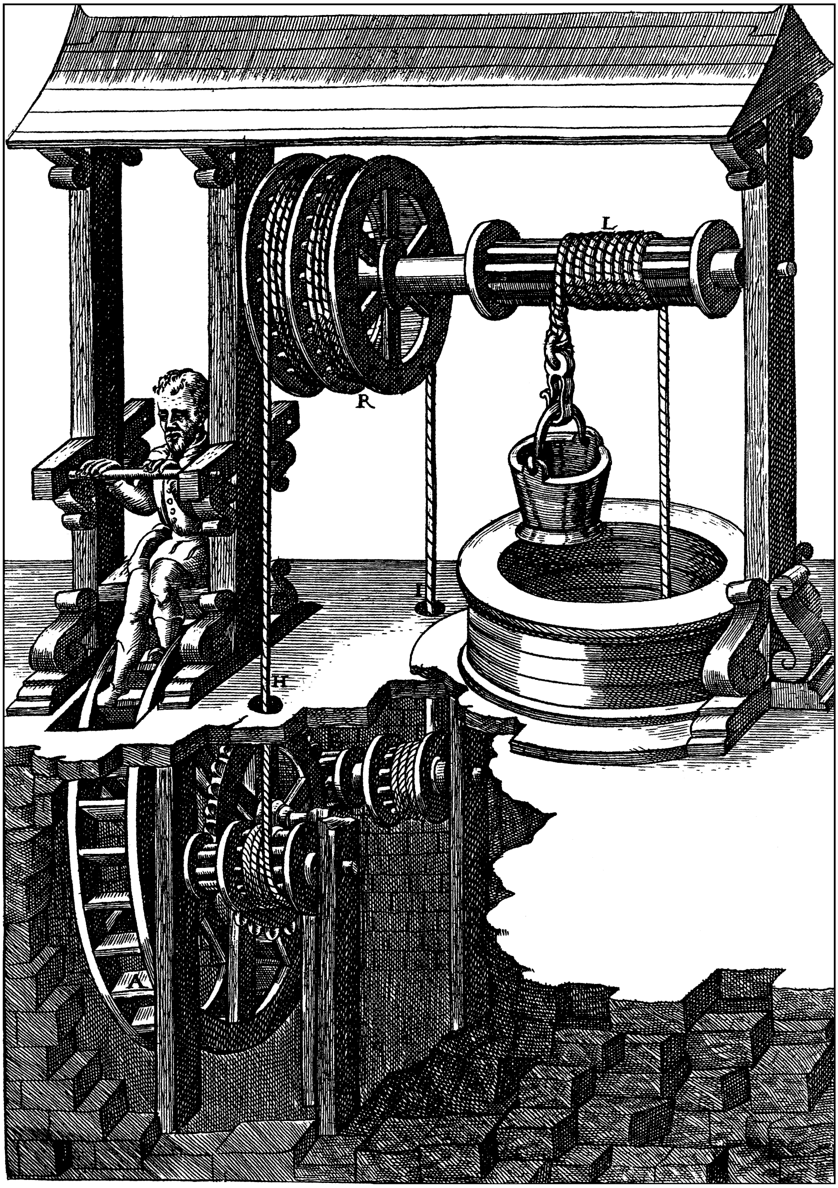

Figure 1.5
Treadmill geared winch (the first recumbent exerciser?). (From Gnudi and Ferguson 1987.)

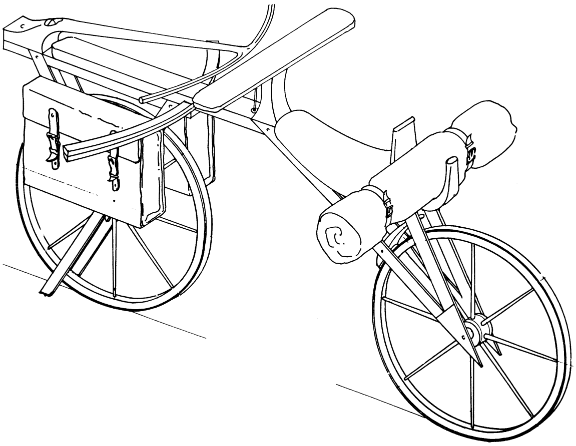

Figure 1.6
Draisienne. (Drawn from Drais's plans by Joachim Lessing; the cloak and side panniers are reconstructed. The wheel diameter chosen by Drais was 690 mm, 27 inches. Courtesy of Hans-Erhard Lessing.)

heim, studied mathematics and mechanics at Heidelberg and was an inventor of a binary digit system, a paper-strip piano-music recorder, a typewriter, and—during a series of bad harvests since 1812—two human-powered "driving machines" on four wheels. In 1815 the Indonesian volcano Tambora exploded, expelling the greatest known mass of dust in the atmosphere (estimated at seven times the amount from Krakatoa in 1883) and making 1816 "the year without a summer" in central Europe and the New England states. Starvation was widespread, and horses were killed for lack of fodder, the price of oats then playing the same role as the oil price today. Lessing believes that the consequent shortage of horses led von Drais to develop his two-wheeled "running machine" with front-wheel steering from the outset (figure 1.6). Our earlier assumption was that he had no preconception that the steering would enable him to balance but simply thought that it would be a convenience. However, Lessing (1995, 130) has made a powerful argument that ice skating, which "had long been a means of travel and transport in the Netherlands with its many canals" led to roller skating. Lessing quotes sources describing "a pair of skates contrived to run on small metallic wheels" to imitate ice skating on theater stages between 1761 and 1772. A preserved flyer for an outdoor demonstration between The Hague and Scheveningen in 1790 shows what appear to be the earliest in-line roller skates. These did not appear in technological magazines of the time, therefore it is hard to tell if von Drais had knowledge of them. But von Drais was an ice skater himself, so balancing on one foot on a skate could have started him thinking about something larger, necessarily with steering. (Roller skates that could be steered were patented by James Plimpton later, in 1863; he became a multimillionaire as a result [Lessing 1995].) A better-documented influence was the rediscovery of the Chinese wheelbarrow (using even a sail) with its central wheel under the load, since this was a topic at the University of Heidelberg.

However it was attained, the major discovery in bicycle history had been made, and it was scarcely recorded. Von Drais's vehicle was, however, noted in the German newspapers in 1817 and those of the United Kingdom in 1818 and the United States in 1819. In Paris, where von Drais obtained a five-year patent (Wolf 1890) it was called *le vélocipède* or the Draisienne, misspelled "Tracena" in the United States initially. In Britain it became known as the Pedestrian Accelerater and was nicknamed Hobby Horse (Street 1998). (Live horses needed constant care. These mechanical "horses" could be used or left at will and were thus treated as a hobby.)

Despite some initial skepticism and ridicule, von Drais was soon demonstrating that he could exceed the speed of runners and that of the horse-pulled "posts," even over journeys of two or three hours. His ability to balance when going down inclines and to steer at speed must have been important in this, but it awed the unathletic majority of the population. He indeed must have the principal claim to being the originator of balance on two wheels by steering.

Von Drais had many imitators. One was the London coachmaker Denis Johnson, who made a seemingly more elegant conveyance having a mainly iron instead of a wooden frame (it was therefore probably a little heavier). It was soon called the "dandy-horse." He set up a school in which young gentlemen could learn to ride. In the next year or so, use of the vehicle could be considered to have spread to clergymen, mailmen, and tradesmen, if contemporary cartoonists are to be taken seriously. However, its cost was too high for it to be used by any but the rich. In 1821, Lewis Gompertz fitted a swinging-arc ratchet drive to the front wheel (figure 1.7) so that the rider could pull on the steering handles to assist his feet. However, by this time so many restrictions had been put upon velocipedes that they lost their usefulness: "[F]or they gave orders that those who rode velocipedes should be stopped in the streets and highways and their money taken from them. This they called putting down the velocipede by fines" (Davies 1837/1986). (Pinkerton [2001] believed that Davis was exaggerating: velocipede users were almost exclusively the very rich and therefore unlikely to be harassed.)

Von Drais's premier place in what might be regarded as the three-step history of the development of the safety bicycle is assured, and it is

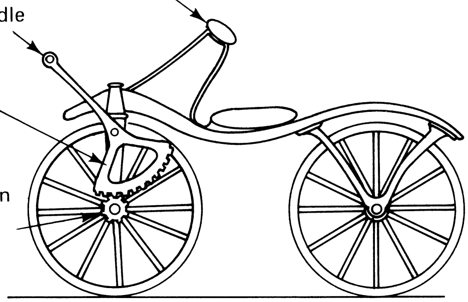

Figure 1.7
Gompertz's hand drive. (Sketched by Dave Wilson.)

relatively free from controversy. In contrast, the second and third steps (and "steps" seems an appropriate name, for they each resulted in "step-changes" in bicycle performance) are shrouded in some mystery and arguments among present-day proponents of one claimant or another.

In the previous edition of this book, and in many other reputable books of bicycle history including Ritchie 1975, credence has been given to a second step being taken in Dumfriesshire, Scotland, in 1839 or 1840 by Kirkpatrick Macmillan, who had been thought to have fitted cranks to the (large) rear wheel of a bicycle, with connecting rods going to swinging arms near the front-wheel pivot point (figure 1.8). Alas! Bicycle inventors seldom leave behind much incontrovertible evidence, and this is certainly true of Macmillan. His claimed development is reckoned by Nicholas Oddy (1990), Hans-Erhard Lessing (1991), and Alastair Dodds (1992) to be another myth. Lessing points out that in the chauvinistic atmosphere of that period (and later!), unscrupulous people repeatedly manufactured "proofs" that someone from their own countries were the first to invent some notable device. (The velocipede credited to Macmillan by a relative was actually the McCall velocipede of 1869, i.e., from step 2.) However, others believe with conviction that Macmillan did in fact produce a rideable pedaled bicycle much earlier than this.

As implied above, the hobbyhorse-velocipede "boom" died down substantially by 1821. The second step in bicycle development had to wait from then until the 1860s (see below). Why so long? One can speculate that the countries in which two-wheeled vehicles had been developed and received with such enthusiasm—principally Germany, France, Netherlands, the United States, and Britain—were now in the grip of railway

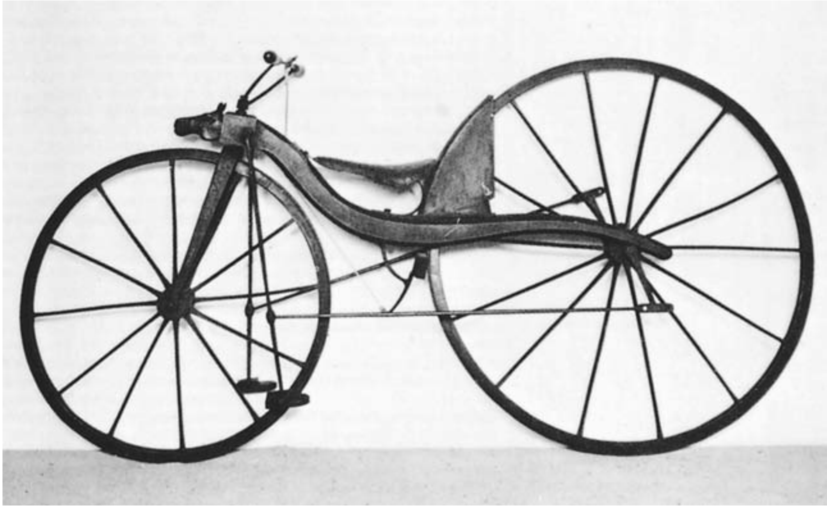

Figure 1.8
A copy of the velocipede attributed by some to Kirkpatrick Macmillan, made around 1869 by Thomas McCall of Kilmarnock. (Reproduced, with permission, from Ritchie 1975.)

mania. There was a new, fast way to travel, and this technology lured the creative dreams and efforts of inventors and mechanics away from the more mundane human-powered transportation. The parallels with what was to happen eighty years later, when the enthusiasm for the safety bicycle was to evaporate before the flaming passion for the automobile, are striking. Lessing (1995) points out that roller skating had lost its popularity on the arrival of the safety bicycle, with the rinks closing down in Europe, but not in the United States.

It would be an exaggeration to claim that all development in human-powered vehicles stopped during this time. From 1817 to 1870 the term "velocipede" was used for any foot-propelled vehicle. Such vehicles were used by some enthusiasts (including Prince Albert, husband of Queen Victoria), but not extensively. The machines' size, weight, and cost and the poor roads deterred walkers from changing their mode of travel. Willard Sawyer, a coachmaker in Kent, England, made increasingly sophisticated four-wheeled velocipedes, such as that shown in figure 1.9, and exported them around the world, from about 1840 to 1870 (McGurn 1999, 24–26). They were used by a few enthusiasts, but no movement developed. Undoubtedly there were lone mechanics and inventors in various countries making what seemed to be improvements to the Draisienne.

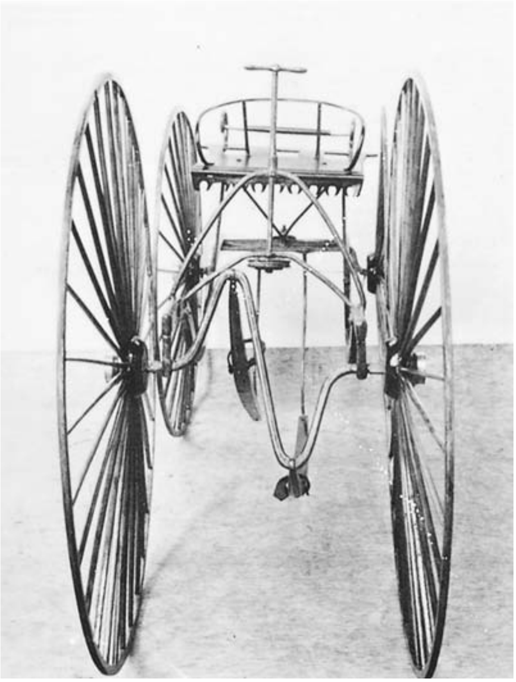

Figure 1.9
A Sawyer four-wheeled velocipede. (Reproduced, with permission, from Ritchie 1975.)

The second step: pedaling propulsion

The next (second) step in bicycle development has become highly controversial. We added a chapter on bicycle history to the second edition of this book. We credited Pierre Michaux with the significant step of adding pedals and cranks to the front wheel of a Draisienne, thus starting the astonishing period that lasted from the 1860s to the turn of the century when at least some parts of the earth appeared to have gone "bicycle-crazy." We were following what we thought were established historical facts. We were quite wrong in perpetuating a myth about the supposed existence of unsteerable hobbyhorses before the advent of the steerable machines of von Drais. (The senior author of the second edition, Frank Whitt, should be absolved with respect to this error. He suffered a severe and eventually fatal stroke early in the work and was, alas, able to contribute only marginally.) We might have been wrong in giving Michaux credit for the pedaled velocipede. Historian David Herlihy (1997) has been researching the contributions of Pierre

Figure 1.10
The first commercial Michaux velocipede. (From Clayton 1998.)

Lallement, who arrived in Brooklyn in 1865 (possibly with a crude bicycle with cranks and pedals) after serving an apprenticeship in Nancy, France. He impressed James Carroll, who provided funds for U.S. patent no. 59,915 (1866; viewable at ⟨www.uspto.gov⟩), the first for such a machine. The Michaux family later claimed that Lallement copied Pierre Michaux's ideas, and many believe that this is true. Herlihy believes that the opposite occurred, and that he can show the relationships among early French pioneers of the pedaled bicycle (H. Cadot, Michaux, Lallement, and the Olivier brothers), who played a major part. Pierre Michaux certainly produced pedaled velocipedes in increasing numbers in 1867–1869 (figure 1.10).

Whoever deserves the credit, there is no doubt about the results. A wild enthusiasm for *le vélocipède bicycle* (the bicycular velocipede) started in Paris in 1868 and spread to Belgium, the Netherlands, Germany, the United States, and Britain. The first true bicycle boom was underway.

Why, and why then? Lessing claims that having learned to ride a bicycle during childhood, we are unable to understand the fear of balancing of former times (unless we try to teach cycling to an unknowing adult). This fear of balancing hindered the earlier mechanics in thinking of two-wheelers with the feet permanently off safe ground. After Meyerbeer's opera *Le prophète* with roller skaters on stage had promoted roller skating throughout the Continent in the 1840s, ice skaters developed the new art of figure skating. Trying to imitate this on roller skates created the need for the "rocking" roller skates with rubber-block steering invented by a Bostonian, James Plimpton, in 1863. His empire of covered roller-skating rinks where the roller skates were rented, never sold, spanned the United States, Europe, and the whole Commonwealth. Roller skating became all the rage in the 1860s, and a large percentage of the rich learned to balance with both feet on wheels. Only on the basis of this broad balancing experience could someone on a two-wheeler ask: why not take the feet off the ground permanently and put them on cranks? Moreover, Paris during this time got new macadamized boulevards that eased the use of the new machine that had double the weight of the Draisiennes. But above all the machine was fun to ride, and thousands did so unimpeded by the authorities.

We might not find their experience so entrancing nowadays. The wooden wheels of the machines they rode had thick compression spokes and iron rims. It was only in the late 1860s that rubber was fastened onto the rims to cushion the harsh ride and ball bearings were first used on bicycles to give easier running (although Davies [1837] mentions that some Draisiennes were fitted with "friction rollers" to lessen the friction). Then the French leadership was lost when, in the Franco-Prussian war of 1870–1871, the French bicycle factories were required to turn to armaments (Ritchie 1975, 61).

What of the apparent lack of American contributions to the mainstream of bicycle development? What happened to the Yankee genius in engineering and mechanics? The U.S. patent office was in fact flooded with applications to patent improvements to velocipedes from 1868 on. The French and British makers found it necessary to follow the developments taking place across the Atlantic (Ritchie 1975, 61 et seq.). In 1869 Pickering's Improved Velocipedes were exported from New York to Liverpool. But the American craze, which *Scientific American* stated had made the art of walking obsolete, suddenly petered out in 1871 as quickly as it had started, leaving new businesses bankrupt and inventors with nowhere to go (Ritchie 1975, 66). There was then a lull until 1877, when the high-wheel bicycle was imported. Colonel Albert Pope started manufacturing them a year later. But conditions in the United States were less conducive for bicycles than those in Europe. In Europe, the high bicycle enabled people to travel much farther than was comfortably possible on a velocipede, and in Britain the roads were good enough for the country to be traversed from Lands End in southwest Cornwall to John O'Groats in northeast Scotland (924 miles; 1,490 km) in seven days (Ritchie 1975, 126–127). In the United States the distances between towns were (except perhaps in New England) enormous, and the roads were poor (Ritchie 1975, 82–83). Accordingly, the bicycle did not have, and did not convey, as much freedom, and the market was therefore smaller and far more dispersed than in Europe. It is doubtful that bicycles were used anywhere in the United States for long-distance travel except by a few enthusiasts and people who wanted to set records.

Development was fast in Britain, however, where production had been started more to fill the unsatiated French demand than to supply any domestic market. Technical leadership in the area was repeatedly taken by James Starley. The suspension or tension wheel had already been tried early in the century and was developed in Paris by Eugene Meyer in 1869 (Clayton 1997) and Grout in 1870. Around 1870 Starley and William Hillman introduced the "lever-tension" wheel, with radial spokes and a lever for tensioning and torque transmission (figure 1.11), and in 1874 Starley patented the logical extension of this idea, the tangent-tension method of spoking (figure 1.12). This has remained the standard spoking method to this day.

The high-wheeler or "ordinary"

With the advent of tension spoking, front wheels could be and were being made larger and larger to give a longer distance per pedal revolution, and therefore greater speed. The Ariel bicycle was patented by Starley on August 11, 1870, having already a larger-than-normal driving wheel. (For a while, some French race organizers tried to restrict the diameter to about a meter (Dodge 1996, 58)—perhaps a harbinger of the restrictions later imposed by the Union Cycliste Internationale (UCI)?)—Starley and others recognized the advantages of using a geared step-up transmission, but experimenters found that the available chains quickly froze up in the grit and gravel of contemporary roads. Soon front wheels were made as large as comfortable pedaling would allow. One bought one's bicycle to fit one's inside leg length. The largest production "high-wheeler" or "ordinary" would have a driving wheel about 60 inches (about 1.5 m) in diameter (figure 1.13). In the English-speaking world we still translate gear ratios into equivalent driving-wheel diameters, and this size corresponds to the middle gear of a typical modern bicycle. (The French and others in Europe use *la developpement*, the wheel's circumference, the distance traveled in one full turn of the cranks.) The 1870s were the years of the dominance of the high-wheeler. By the end of the decade, top-level bicycles were made with ball bearings in both wheels and in the steering head, the rims and forks were formed from hollow tubing, the steer axis had been tilted to create a castering effect, the tire rubber was greatly improved over the crude type used in 1870, and racing bicycles had been reduced to under 30 lb (13.6 kg). A ridable James ordinary weighing only 11 lb (5 kg) was produced in 1889.

Figure 1.11
The Starley-Hillman lever-tension wheel, 1870, shown by the late John Pinkerton in 2001. (Photo: Dave Wilson.)

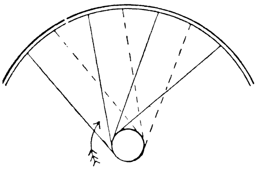

Figure 1.12
Tangent-tension spoking. (From Sharp 1896.)

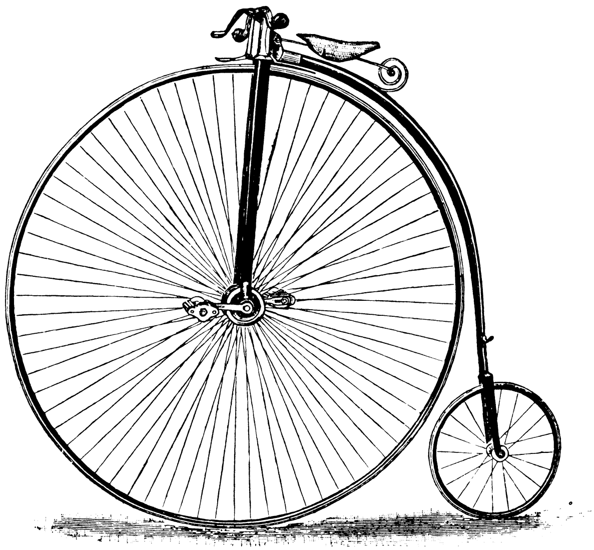

Figure 1.13
The ordinary, or high-wheeler, or penny-farthing. (From Sharp 1896.)

The ordinary was responsible for the third two-wheeler passion, which was concentrated among the young upper-class men of France, Britain, and the United States and was fostered by military-style clubs with uniforms and even buglers (Dodge 1996, 82–84). The ordinary conferred unimagined freedom on its devotees; it also engendered antipathy on the part of the majority who didn't or couldn't bicycle. Part of the antipathy was envy. The new freedom and style were restricted to rich young men. Strict dress codes prevented all but the most iconoclastic of women from riding high-wheelers. Family men, even if they were still athletic, hesitated to ride because of the reported frequent severe injuries to riders who fell (some feel that these reports were exaggerated). Unathletic or short men were excluded automatically. These prospective riders took to tricycles (Sharp 1896, 165–182), which for a time were produced in as many models as the ordinaries.

There were two technological responses to the need to serve the "extra-ordinary" market. James Starley played a prominent role in the first, and his nephew, John Kemp Starley, in the second.

Tricycles and quadricycles

The first of these responses was the development of practical machines of three or four wheels in which the need to balance was gone and the rider could be seated in a comfortable, reasonably safe, and perhaps more dignified position. Such vehicles had been made at different times since at least the start of the century, but the old heavy construction made propelling them a formidable task. In fact, the motive power was allegedly often provided by one or more servants, who in effect substituted for horses (there is considerable doubt about the truth of these reports). Starley's Coventry Tricycle, patented by Starley's son and nephew in 1876, could be used with comparative ease by women in conventional dress and by relatively staid males. The Starleys produced this vehicle for several years from 1877. Early in the production run it was also made with more-conventional cranks with circular foot motion (figure 1.14). (The early version was then called the Coventry Lever tricycle, and the latter the Coventry Rotary.) Starley had found a chain that worked, at least in the possibly more protected conditions of a tricycle. The Coventry Lever and its successors had one large driving wheel on the left of the seat and two steering wheels, one in front and one behind, on the right. Starley saw the advantage of two large driving wheels on either side of the rider(s) and a single steering wheel in front. For this arrangement to work, power had to be transmitted to two

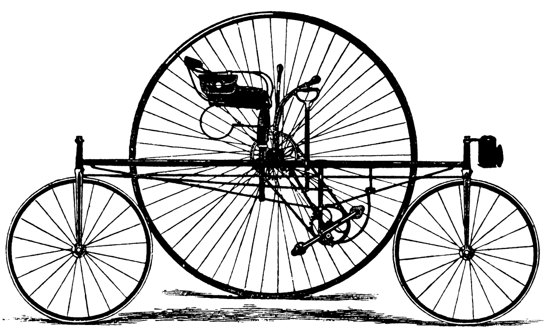

Figure 1.14
Starley's Coventry rotary tricycle. (From Sharp 1896.)

wheels, which, in a turn, would be going at different speeds. Starley reinvented the ''balance gear'' (Sharp 1896, 240–241), which is now known as the differential. Starley's Royal Salvo tricycle became the predominant form—for single riders, for two sitting side-by-side, and even for one behind the other (figure 1.15). This is not to say that there were no other forms; the reverse of this arrangement, for instance, with the steering wheel trailing the large driving wheels, was used for tradesmen's carrier machines (Pinkerton 1983). But the front-steerer was perceived as giving better control (one did not have to steer the rear wheel toward a pedestrian or a pothole to take avoiding action, as is necessary with rear-steerers).

Gradually the front wheel was made larger and the driving wheels smaller, as could be done with chain drives of increasing efficiency and reliability. By 1884 or 1885 the front wheel was connected directly to the handlebars (figure 1.16). This was a simpler and more reliable arrangement than the rack-and-pinion and other indirect systems that had been used. The modern tricycle had evolved, with the modern riding position in which one sits or stands almost over the cranks and splits the body weight among handlebars, pedals, and saddle.

This modern tricycle of late 1884/early 1885 was also very similar to the emerging form of the modern bicycle. In fact, the second response to the exclusion of so many from the high-wheeler movement was the

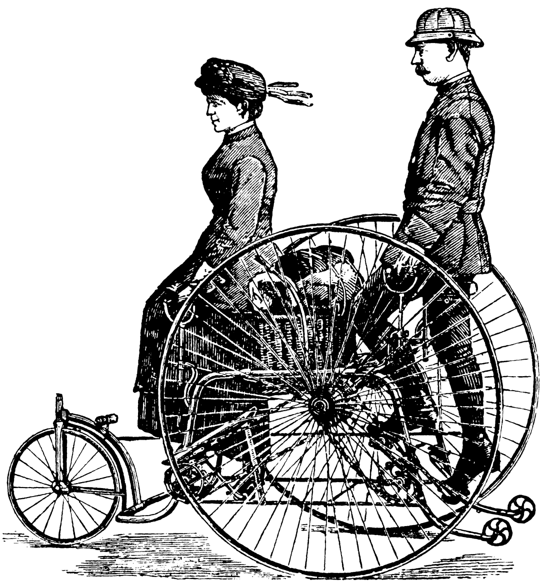

Figure 1.15
Starley's Royal Salvo tricycle. (From Sharp 1896.)

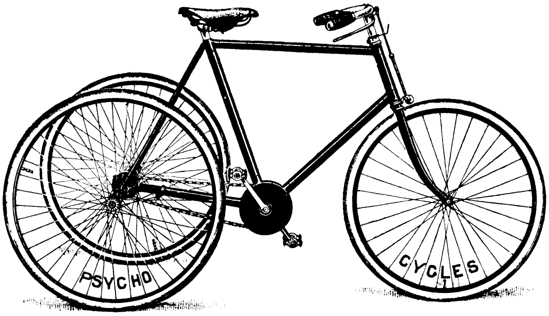

Figure 1.16
An early modern tricycle. (From Sharp 1896.)

development of a configuration that would make less likely a headfirst fall from a considerable height, that could be ridden in conventional dress, and that did not require gymnastic abilities.

Some improvements to the high-wheeler fulfilled only the first of these desiderata. Whatton bars (figure 1.17) were handlebars that came under the legs from behind, so that in the event of a pitch forward the rider could land feet first. (Cycle clubs—but not the police—recommended that riders of standard high-wheelers put their legs over the handlebars when going fast downhill, as in figure 1.18, for the same reason.) Some modern recumbent bicycles have similar handlebar arrangements. The designer of the American Star took the approach of making over-the-handlebars spills much less likely by putting the small wheel in front, giving it the steering function, and reducing the wheel size by using a lever-and-strap drive to the large wheel through one-way clutches (figure 1.19). Unfortunately, this arrived too late (1881) to have much impact, because the true "safety" bicycle was evolving rapidly by that date. Another type of bicycle that was safer to ride than the high ordinary was the "dwarf" front-driver, such as Hillman's 1884 Kangaroo (figure 1.20 shows an 1886 Kangaroo Dwarf Roadster) with a geared-up drive to a smaller front wheel (Sharp 1896, 152, 158). Such machines were offered because riders accustomed to front-drive machines did not always take kindly to the rear-drive safeties. Small-wheeled Bantam bicycles with an epicyclic hub gear (figure 1.21) were marketed as late as 1900.

The third step: the arrival of the modern "safety" bicycle

It had long been recognized that it would be most desirable from the view-point of safety to have the rider sitting between two wheels of moderate

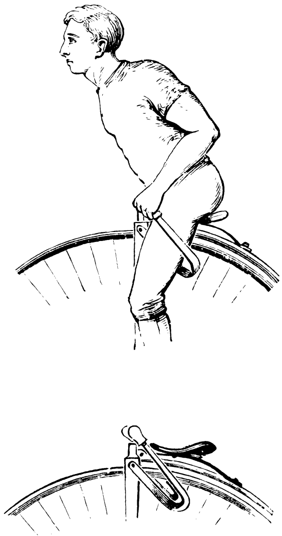

Figure 1.17
Whatton bars. (From *Cycling* [1887].)

Figure 1.18
"Coasting—Safe and Reckless." (From *Cycling* [1887].)

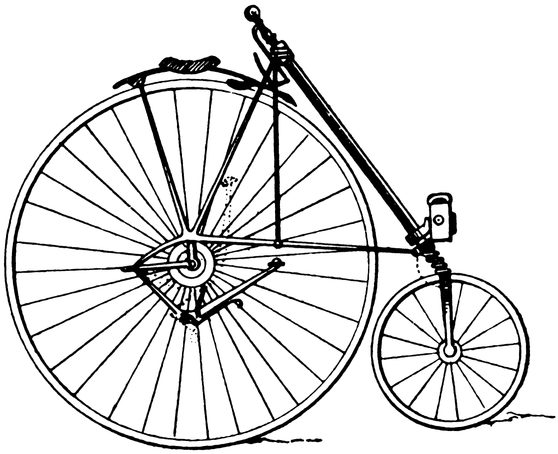

Figure 1.19
The American Star, a treadle-action bicycle of 1880. (From Baudry de Saunier 1892.)

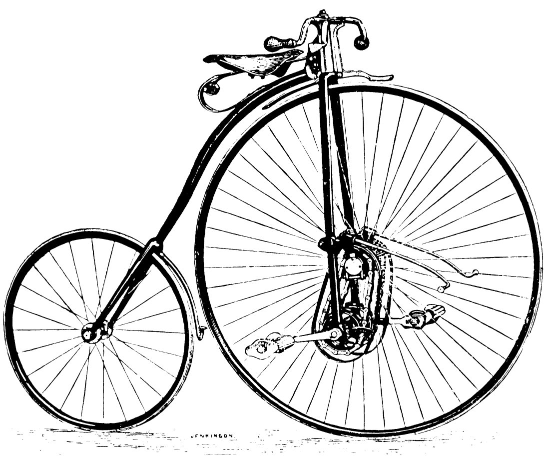

Figure 1.20
1886 Kangaroo Dwarf Roadster. (From Sharp 1896.)

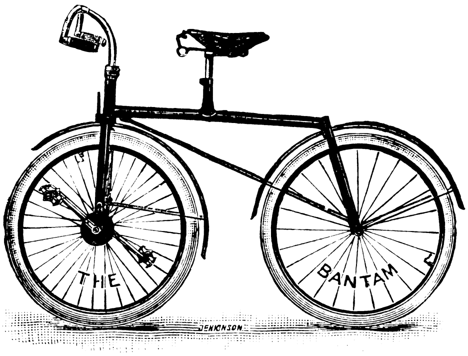

Figure 1.21
Bantam geared front-drive safety bicycle. (From Sharp 1896.)

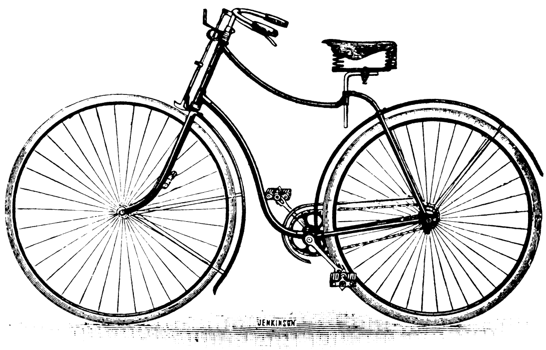

Figure 1.22
Starley safety bicycle. (From Sharp 1896.)

size. Many attempts were made over the years. The first Paris velocipede show, at which rubber tires, variable gears, free-wheels, tubular frames, sprung wheels, and band brakes were shown, was held in 1869. But the direct ancestors of today's bicycles evolved rapidly in the one or two years before 1885, when several were shown in Britain's annual Stanley Bicycle Show. James Starley had died in 1881, but his nephew John Kemp Starley, working with William Sutton, produced a series of Rover safety bicycles (Pinkerton and Roberts 1998) in 1885 that, by the end of that year, had direct steering and something very close to the diamond frame used in most bicycles today (figure 1.22).

One major development in the mainstream flowing to the modern bicycle remained: the pneumatic tire. This was patented in 1888 by John

Boyd Dunlop, a Scottish veterinarian in Belfast, although another Scot, R. W. Thomson, had patented pneumatic tires for horse-drawn vehicles in 1845 (Thomson 1845), and some were still in use in the 1880s (Du Cros 1938). Dunlop's early tires (made to smooth the ride of his son's tricycle) were crude, but by May 1889 they were used by W. Hume in bicycle races in Belfast—and he won four out of four. Success in racing in those days gave a clear signal to a public confused by many diverse developments. Cyclists saw that, as in the case of the safety versus the high-wheeled bicycle, a development had arrived that promised not only greater speed, or the same speed with less effort, but greater comfort and, especially, greater safety. Within eight years, solid tires had virtually disappeared from new bicycles, and Dunlop was a millionaire in pounds sterling.

With the arrival of the pneumatic-tired direct-steering safety bicycle, only refinements in components remained to be accomplished before the modern-day bicycle could be said to have been fully developed. Various types of epicyclic spur-gear variable-ratio transmissions for the brackets and rear hubs of chain-driven safety bicycles came on the market in Britain in the 1890s. Some heavier devices were available earlier for tricycles. The Sturmey-Archer three-speed hub (1902) was the predominant type, as it still is in many parts of the world (Hadland 1987), but there were many competitors at the turn of the century. The derailleur or shifting-chain gear was developed in France and Britain in 1895 but was not popular. It was developed by degrees in Europe and was eventually accepted for racing in the 1920s (Berto, Shepherd, and Henry 1999).

Undoubtedly, much more will be discovered about the history of the modern traditional single-rider bicycle, and unrecognized inventors will receive the honor due them. Inquiring readers can find much more history than we have space for here in the excellent books referenced and those listed at the end of the chapter.

Waxing and waning enthusiasm

Although the enormous enthusiasm for the bicycle that was found in most "Western, developed" countries in the 1890s waned sharply toward the end of the decade, that is not to state that the bicycle fell into wide disuse. Not many workers could afford bicycles, but they were used by well-to-do people for commuting and shopping, and later, in Europe at least, for sport and for weekend and vacation travel mainly by the "cloth-cap" (i.e., working) class. The hapless author was not allowed to ride a bicycle until he was nine (and then he was allocated an old single-speed "clunker"), and he was given an old three-speed "sports" bike when he was eleven, in 1939, the year war was declared in Europe. Petrol ("gas") was first rationed and then made unavailable for private use in Britain during World War II, and the bicycle was used widely. Riding with my elder brothers and mother and father was an important part of growing up. Going with my schoolboy friends to see local bomb damage and downed planes, to visit local towns for attractions such as swimming holes, and to plan increasingly longer trips ending with a 1,000-mile (1,600-km) tour into Scotland in 1944 were all liberating and, one hopes, character-forming activities. The camaraderie of European bicyclists everywhere made trips of any length very enjoyable.

When motor fuel and cars became available and affordable again (well after the Second World War ended), the bicycle in many Western countries was reduced to being used by children and by what were seen as fringe groups. In the third world, the bicycle was a necessity for anyone who could afford one. In most of these countries and especially in China, the proportion of person-trips and even of freight moved by bicycle were and possibly still are far higher than that taken by the railroads and road traffic.

A modern bicycle boom started in the United States in around 1970, for reasons difficult to discern. (It followed rather closely the end of a two-year competition in the design of human-powered vehicles organized by the author that created considerable public interest at the time, so that he is tempted to puff himself up to take credit, just as the cock crows at the dawn he has obviously caused.) Sales of bicycles rose rapidly to exceed comfortably the annual sales of automobiles. The buyers were overwhelmingly middle-class, college and professional people, U.S. bicycling thereby contrasting with the center of gravity of the sport in Britain. At the start, the popular style was the "English bicycle," predominantly Raleigh three-speed models, but soon "English racers" (an increasing proportion being actually French and Japanese), nowadays called "ten-speeds," became fashionable.

All-terrain bicycles

Most of these "road" bicycles enthusiastically purchased in the United States were used for a few kilometers and then left unridden, so that the bicycle boom began to peter out. But in 1970, at the time the enthusiasm for lightweight road bikes in the United States was increasing, a few enthusiasts in Marin County, California, began experimenting with old Schwinn clunkers for downhill off-road racing (Berto 1998). Others had done so in different countries before this, but they had not started a movement. Berto interviewed nine then-young men who, in this small area of California, continued experimenting throughout the 1970s with configurations of bicycles that gave advantages first for fast purely downhill travel and later for cross-country and uphill riding. Several started companies to produce the designs they developed. Rather suddenly, "beginning around

1982, a sea change affected the sales of bicycles in America and Europe. The buyers switched from road bikes to all-terrain or 'mountain' bikes. Tires went from skinny to fat, and riders went from a crouched position on dropped handlebars to a more erect position on flat handlebars" (Berto 1998, 25). This second boom in popularity of bicycles has been different in character from the road-bike boom, because a far higher proportion of the bikes purchased has been used to a significant extent. Perhaps most have not in fact been used for off-road recreation but have been seen as an extremely practical bike for negotiating rough urban streets in commuting or shopping use. They have left far behind their original heavy clunker image and have become high-tech lightweights. They have reached extraordinary levels of sophistication, many having front and rear suspension, wide-range twenty-seven-speed gears, hydraulic disk brakes, and frames made from aluminum, titanium, or carbon fiber. The technology developed for so-called mountain bikes is leading the bicycle industry generally. However, at the time of writing (2003) the sales of ATBs have peaked and are falling somewhat. Enthusiasts for "recumbent" bicycles wonder if there will be another bike boom featuring their configuration.

Recumbents

One reason for discussing recumbents rather than tandems, folding bicycles, pedicabs, or goods transporters is that most modern record-breaking machines are recumbents. Another is that greater safety can result from the use of the recumbent riding position in highway bicycles. In addition, what we know of the history of this variant form might help to illustrate the past and present character of the cycle industry.

Many early cycles (particularly tricycles) used the semirecumbent position. The "boneshaker" was often ridden with the saddle well back on the backbone spring and the feet at an angle considerably higher than that for the modern upright safety. In contrast with the riders of the high-wheeler and of the safety, who were told to position the center of gravity vertically over the center of the crank, the semirecumbent rider sits in something like a chair and puts her/his feet out forward on the pedals. The pedal-force reaction is taken not by the weight of the body (or, when that is exceeded, by pulling down on the handlebars), but by the backrest.

The first known semirecumbent bicycle (by which we mean one in which the rider's center of gravity was low enough relative to the front-wheel road contact point for there to be a negligibly low possibility of his being thrown over the front wheel in an accident) was built in Geneva by Challand (von Salvisberg 1897, 47) sometime before 1895 (figure 1.23). Challand called it the Normal Bicyclette. The rider sat rather high, directly

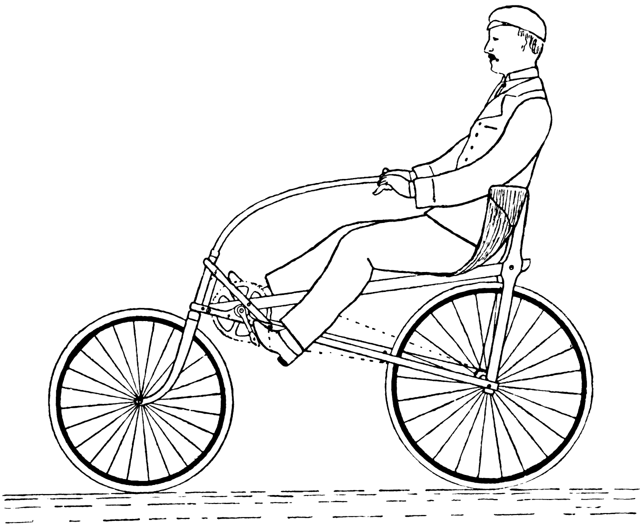

Figure 1.23
Challand's recumbent bicycle, 1896. (From von Salvisberg 1897, p. 47.)

over the rear wheel. In 1897 U.S. patent no. 577,895 was awarded to I. F. Wales for a somewhat strange-looking recumbent bicycle with hand and foot drive (figure 1.24) (Barrett 1972). A much more modern-looking recumbent bicycle was constructed by an American named Brown and taken to Britain in 1901 (figure 1.25) (Dolnar 1902). By this time orthodoxy rested firmly with the traditional safety bicycle, and the derision that had successively greeted the Draisienne, the velocipede, and the safety had been forgotten. Dolnar's review of the Brown recumbent in *The Cyclist* of January 8, 1902, was derisive to the point of sarcasm:

The curiously unsuitable monstrosity in the way of a novel bicycle shown in the single existing example of Mr. Brown's idea of the cycle of the future here illustrated.... The illustration(s) fully show(s) the rider's position and the general construction of this crazy effort.... The weight (30 lb.) and cost of the machine are greatly increased.... The mounting and dismounting are easy, and this is a fine coasting machine, the great wheel-base making very smooth riding ... and turns in a small circle. The machine runs light and is a good hill-climber, and it is only fair to say that the general action of this queerest of all attempts at cycle improvement is easy and good—far better than its appearance indicates.... The surprising fact is that any man in his sober senses could believe that there was a market for this long and heavy monstrosity at the price of a hundred dollars (£20).

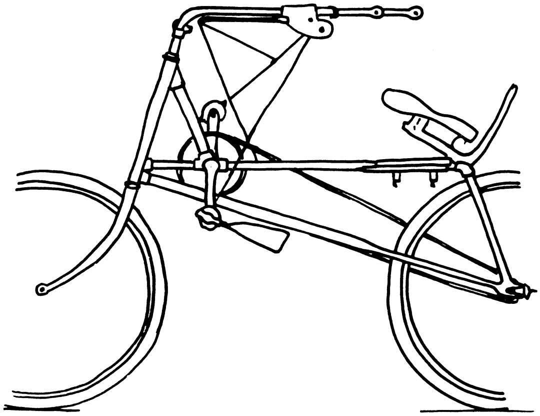

Figure 1.24
Design for hand-and-foot-powered recumbent patented by I. F. Wales in 1897. (Sketched by Frank Whitt.)

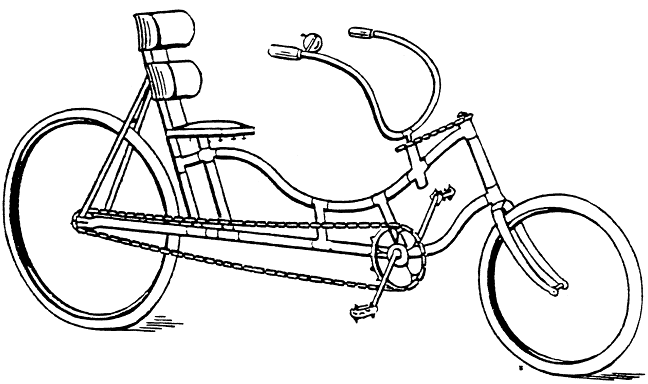

Figure 1.25
Brown's 1900 recumbent bicycle. (From a sketch of the Sofa Bicycle in *The Cyclist* (U.K.), November 13, 1901, p. 785.)

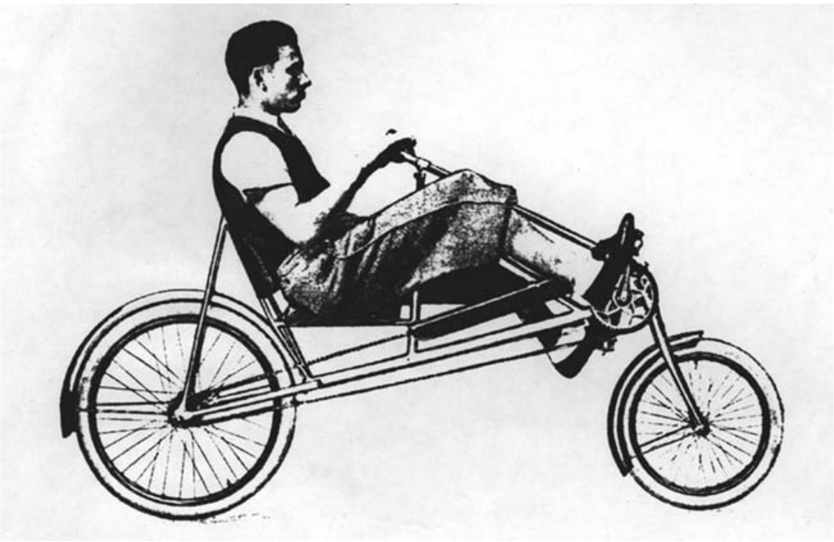

Figure 1.26
The Velocar. (From the advertisement of a licensor.)

Recumbents were more successful in Europe. After the First World War, the Austrian Zeppelin engineer (and, later, car designer) Paul Jaray built recumbents in Stuttgart in 1921 (Lessing 1998b).

A racing recumbent called the Velocar (figure 1.26) was developed in France in 1931–1932, from four-wheeled pedaled vehicles of that name (Schmitz 1994). With a Velocar, a relatively unknown racing cyclist, Francis Faure, defeated the world champion, Henri Lemoine, in a 4-km pursuit race and broke track records that had been established on conventional machines ("The Loiterer" 1934). A genuine orthodoxy pervaded the bicycle industry and the UCI, which controlled world bicycle racing. Instead of setting up a procedure and special category for machines such as the Velocar, the UCI, at the urging of the cycle trade, banned unconventional types from organized competition. This decision denied novel ideas the opportunity of being tested and publicized through racing and thereby deterred experimentation and development.

Only with the open-rule human-powered-vehicle competitions, started in California in 1974 (and resulting in the International Human Powered Vehicle Association, or IHPVA) has the inventiveness of human-powered-vehicle designers been given an incentive. With all classes of "open" races now being won by recumbent machines of a large variety of types, the technological history of this vehicle, and of bicycles in general, is again being written. The single-rider 200-m flying-start record for a streamlined bicycle is 130.3 km/h in 2002 and is likely to be faster by the time this book is published. These are exciting times. We wonder (and this is just speculation on the part of the author) if there may not also be a parallel in this new period of development with the period that started around 1866. The excitement over railway travel had seemed to drain away either the excess energies of inventors or the support for their activities, so that bicycle development languished. Occasional inventions like those of Gompertz were not followed up. But perhaps by the mid-1860s the railway was accepted, and it was apparent that it was not going to solve all transportation problems. Similarly, in the 1890s the motorcar arrived, and suddenly it was fashionable not only to travel in one, but to be involved in developing them. And two bicycle mechanics produced the first successful powered airplane only a little later. From then almost until the present day there has been a widely acknowledged love affair with the automobile, and with the airplane, first in the developed countries and later in the undeveloped countries. Only when disenchantment set in over the damage that these methods of transportation were inflicting on our cities did widespread enthusiasm for bicycle development surface once more.

May future histories record that new developments led to a new wave of popularity for human-powered travel, one that will last longer than some of the booms of the past.

Bicycle technology

For partisans of the bicycle, it is a matter of pride that the bicycle has frequently led to new technologies, or even fertilized new industries, such as

- mass production and use of ball bearings;
- production and use of steel tubes;
- use of metal stamping in production;
- differential gearing;
- tangent-spoked wheels (later used in cars, motorcycles, airplanes);
- bushed power-transmission chain;
- mass production and use of pneumatic tires;
- good-roads movement;
- Harley and Davidson, bicycle racers;
- Wright brothers, bicycle manufacturers; and
- the underpinnings of the automobile age.

Note

1. John Pinkerton, a long-time rider of high bicycles, believed that the supposed dangers are highly exaggerated.

References

Barrett, Roy. (1972). "Recumbent cycles." *The Boneshaker* (Southern Veteran-Cycle Club, U.K.):227–243.

Baudry de Saunier, L. (1892). *Le cyclisme, théoretique et pratique*. Paris: Libraierie Illustre.

Berto, Frank J. (1998). "Who invented the mountain bike?" In *Cycle History: Proceedings of the 8th International Cycle History Conference, Glasgow, Scotland, August 1997*. San Francisco: Van der Plas.

Berto, Frank, Ron Shepherd, and Raymond Henry. (1999). *The Dancing Chain*. San Francisco: Van de Plas.

Clayton, Nick. (1997). "Who invented the penny-farthing?" In *Cycle History: Proceedings of the 7th International Cycle History Conference, Buffalo, NY, 1996*. San Francisco: Van der Plas.

Clayton, Nick. (1998). *Early Bicycles*. Princes Risborough, U.K.: Shire.

Cycling. (1887). Badminton Library. London: Longman's, Green.

Davies, Thomas Stephens. (1837). "On the velocipede." Address to the Royal Military College, Woolwich, U.K. Reported in *The Boneshaker*, nos. 108 and 111 (1986), with notes by Hans-Erhard Lessing.

Dodds, Alastair. (1992). "Kirkpatrick MacMillan—Inventor of the bicycle: Fact or fiction." In *Proceedings of the 3rd International Cycle History Conference*. Saint Etienne, France: Ville de Saint Etienne.

Dodge, Pryor. (1996). *The Bicycle*. Paris: Flammarion.

Dolnar, H. (1902). "An American stroke for novelty." *The Cyclist* (London) (January 8):20.

Du Cros, Arthur. (1938). *Wheels of Fortune*. London: Chapman & Hall.

Gnudi, Martha Teach (translator), and Eugene S. Ferguson (annotator). (1987). *The Various and Ingenious Mechanisms of Agostino Ramelli (1588)*. New York: Dover Publications, and Aldershot, U.K.: Scolar.

Hadland, Tony. (1987). *The Sturmey-Archer Story*. Self-published (U.K.).

Herlihy, David V. (1997). "H. Cadot and his relevance to early bicycle history." In *Cycle History: Proceedings of the 7th International Cycle History Conference, Buffalo, NY, September 1996*. San Francisco: Van der Plas.

Lessing, Hans-Erhard. (1991). "Around Michaux: Myths and realities." In *Actes de la deuxieme conference internationale sur l'histoire du cycle, St. Etienne, France*, vol. 2. Saint-Etienne, France: Ville de Saint-Etienne.

Lessing, Hans-Erhard. (1995). “Cycling or roller skating: The resistible rise of personal mobility.” In *Cycle History: Proceedings of the 5th International Cycle History Conference*. San Francisco: Van der Plas.

Lessing, Hans-Erhard. (1998a). “The evidence against ‘Leonardo’s bicycle.’” In *Cycle History: Proceedings of the 8th International Cycle History Conference, Glasgow, August 1997*. San Francisco: Van der Plas.

Lessing, Hans-Erhard. (1998b). “The J Wheel—Streamline pioneer Paul Jaray’s recumbent.” In *Cycle History: Proceedings of the 9th International Cycle History Conference, Ottawa, Canada, August 1998*. San Francisco: Van der Plas.

“The Loiterer.” (1934). In “Velocar versus normal,” *Cycling* (March 2):202.

McGurn, Jim. (1999). *On Your Bicycle: The Illustrated Story of Cycling*. York, U.K.: Open Road.

Oddy, Nicholas. (1990). “Kirkpatrick MacMillan, the inventor of the pedal cycle, or the invention of cycle history.” In *Proceedings of the 1st International Cycle History Conference, Glasgow*. Cheltenham, U.K.: Quorum Press.

Pinkerton, John. (1983). At Your Service: A look at Carrier Cycles. Birmingham, U.K.: Pinkerton Press.

Pinkerton, John. (2001). Personal communication with D. G. Wilson, September.

Pinkerton, John, and Derek Roberts. (1998). *A History of Rover Cycles*. Birmingham, U.K.: Pinkerton Press.

Reti, L., ed. (1974). *The Unknown Leonardo*. New York: McGraw-Hill.

Ritchie, A. (1975). *King of the Road*. Berkeley, Calif.: Ten Speed Press.

Roberts, Derek. (1991). *Cycling History—Myths and Queries*. Birmingham, U.K.: Pinkerton Press.

Schmitz, Arnfried. (1994). “Why your bicycle hasn’t changed for 106 years.” *Human Power* 13, no. 3 (1994):4–9; reprint of article originally published in *Cycling Science* (June 1990).

Sharp, Archibald. (1896). *Bicycles and Tricycles*. London: Longmans, Green; reprint, Cambridge: MIT Press, 1977.

Street, Roger. (1998). *The Pedestrian Hobby-Horse at the Dawn of Cycling*. Christchurch, U.K.: Artesius Publications.

Thomson, R. W. (1845). “Carriage wheels.” U.K. patent no. 10,990.

Von Salvisberg, P. (1897). *Der Radfahrsport in Bild und Wort*. Munich, 1897; reprint, Hildesheim, Germany: Olms Presse, 1980.

Wilson, David Gordon. (1977). "Human muscle power in history." In *Pedal Power*, ed. James C. McCullagh. Emmaus, Penn.: Rodale.

Wolf, W. (1890). "Fahrrad und Radfahrer." Spamer, Leipzig; reprint Dortmund, Germany: Hitzegrad, 1979.

Zabaglia, N. (1743). *Castelli e Ponti*. Rome.

Recommended reading

Cycling History, vols. 1–16 (1991–2002). Volumes 1–3 are out of print and available only in some libraries. Volumes 4 onward are published by Van der Plas Publications, San Francisco.